MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2022/2023 (TERM ID 2220)

TIT3131 – INFORMATION THEORY

(All sections / Groups)

6 JULY 2023
9.00 am – 11.00 am
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This question paper consists of 6 pages with **Four** questions only.
2. Attempt **All** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

QUESTION 1

Question 1 contains **10 MCQ** questions, please choose the best answer and write it clearly in the answer booklet.

(a) Information theory applies the laws of probability, and mathematics in general, to study the collection and manipulation of information. [1 mark]

[A] TRUE.
[B] FALSE.

(b) The amount of information, $I(S_k)$ is related to the inverse of the probability of occurrence. [1 mark]

[A] TRUE.
[B] FALSE.

(c) $\mathbf{H(S^{100})}$, the entropy of the extended source, is equal to 200*$\mathbf{H(S)}$, the entropy of the original source. [1 mark]

[A] TRUE.
[B] FALSE.

(d) Given an DMS, S = {A, B, C, D} and the probability of occurrence for these symbols are showed in the **Table 1**. Calculate the information gained for symbol B. [1 mark]

Table 1

S_k	A	B	C	D
p_k	0.1	*0.2*	*0.3*	*0.4*
$I(S_k)$				

[A] $I(S_B) = 3.3219$ bit/symbol
[B] $I(S_B) = 2.3219$ bit/symbol
[C] $I(S_B) = 1.3219$ bit/symbol
[D] None of the above.

(e) A prefix code is defined as the code in which no code word is the prefix of any other code word. [1 mark]

[A] TRUE.
[B] FALSE.

(f) Block codes in which message bits are transmitted in unaltered form are called systematic codes. [1 mark]

[A] TRUE.
[B] FALSE.

Continued...

(g) The mutual information of a channel is symmetric, that is the mutual information of $I(X,Y)$ equal to $I(Y,X)$. [1 mark]

[A] TRUE.
[B] FALSE.

(h) From the **Table 2** below, given that the Code I is a prefix code, estimate a suitable code for x. [1 mark]

Table 2

Symbol	Code 1
A	000
B	001
C	x
D	1000

[A] $x = 000$.
[B] $x = 100$.
[C] $x = 0010$.
[D] None of the above.

(i) Given that message m = (10110). The message polynomial $M(D)$ is equal to $1 + D^2 + D^5$ [1 mark]

[A] TRUE
[B] FALSE

(j) Consider a generator matrix (6, 3) linear block code below. The generator matrix is expressed in non-systematic form. [1 mark]

$$G = \begin{bmatrix} 0 & 1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & 0 & 1 & 0 \\ 1 & 1 & 0 & 0 & 0 & 1 \end{bmatrix}$$

[A] TRUE
[B] FALSE

Continued...

QUESTION 2

(a) Consider the following source with discrete memoryless source with source alphabet $S = \{S_0, S_1, S_2\}$ with $p_0 = 0.5$, $p_1 = 0.25$, $p_2 = 0.25$. Prove that $H(S^2) = 2$ H(S). [3 marks]

(b) Construct the encoder circuit for the generator polynomial for a (6, 3) cyclic code generated by $g(D) = 1 + D^2 + D^3$. [4 marks]

(c) Given convolutional code of path 1, path 2 and path 3 in **Figure 1**. Find g1, g2 and g3.

[3 marks]

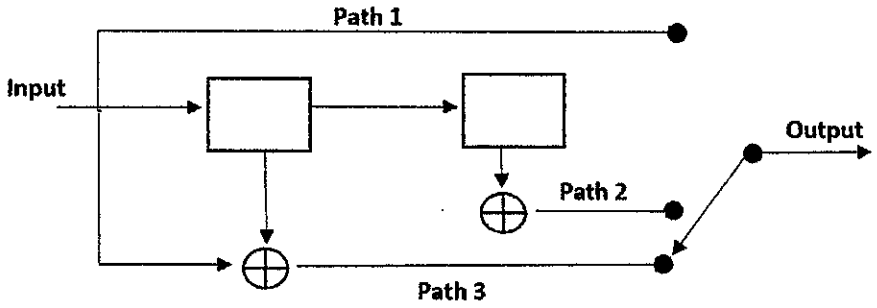

Figure 1

QUESTION 3

(a) From the **Figure 2** below, given that $P(X) = \{0.58, 0.42\}$. Show that $\mathbf{I}(Y,X)$ is equal to $\mathbf{I}(X,Y)$. You must show all the necessary steps.

[8 marks]

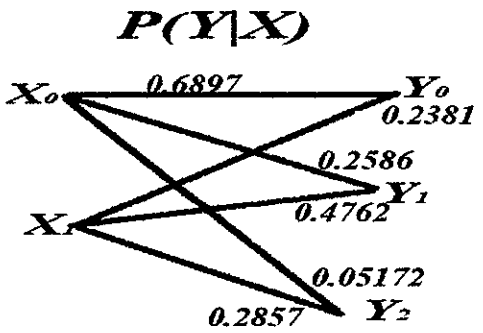

Figure 2

(b) From the **Table 3** below, use Kraft inequality to determine whether the following code are unique decodable. You must show all the necessary steps.

[2 marks]

Table 3

Symbol	Code I	Code II
A	000	00
B	001	11
C	010	10
D	1111	111

Continued...

QUESTION 4

(a) A discrete memoryless source produces one of the five outputs $\{A, B, C, D, E\}$ randomly. The corresponding output probabilities are 0.3, 0.25, 0.2, 0.15 and 0.1.

i) Create a Huffman tree and encoding table for the source. You must show all the necessary steps. [4 marks]

ii) Calculate the efficiency of this code. [3 marks]

(b) Consider the generator polynomial for a (6,3) cyclic code generated by $g(D) = 1 + D + D^3$. Construct all the valid code words for the following messages in **"non-systematic"** form. Show your steps.

[3 marks]

Message	m(D)	c(D)	Code word
001			
010			
011			

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